ROADWAY (100)

110.0 BITUMINOUS PAVEMENTS

Become familiar with instructions in traffic control, safety and convenience of traffic, and protection of workmen before beginning work on the traveled way.

It is recommended that the District Maintenance Engineer or Regional Engineer and the appropriate District Maintenance personnel establish and review annually the bituminous pavement maintenance needs for each section of roadway in the District. From this review a list of candidate projects can be established for both rehabilitation and maintenance type work. Pavement Management System (PMS) reports can provide useful information to assist in determining candidate projects.

It has been shown that the most cost effective pavement maintenance is preventive maintenance. Preventative maintenance is based on the concept that periodic inexpensive treatments are more economical than infrequent high cost treatments. Pavement preventative maintenance is defined as a program strategy intended to arrest light deterioration, retard progressive failures, and reduce the need for routine maintenance and service activities.

Pavement preventative maintenance treatments preserve, rather than improve, the structural capacity of the pavement structure. Preventative maintenance treatments are limited to pavements in sound structural condition. In addition, in order to be effective, preventative maintenance should be applied before pavements display significant amounts of environmental distress such as raveling, oxidation and block cracking.

Several types of treatments can be used for preventative maintenance:

- Crack Treatment
- Fog Seal and Rejuvenators
- Chip Seal
- Thin Hot Mix Overlay (Dense)
- Thin Hot Mix Overlay (Open-Graded)
- Slurry Seals
- Microsurfacing
- Scrub Seals
- Cold-in-Place Recycling
- Hot-in-Place Recycling
- Novechip

Information on the preventive maintenance and other routine maintenance techniques that are typically accomplished by state maintenance forces are presented in the following subsections. For information on the preventive maintenance techniques

that would typically be accomplished by contracting, refer to publications such as, Asphalt Institute Manual ES-11, ES-12, MS-16 or MS-19. Information can also be found in the ITD Standard Specifications or the Materials Manual.

110.1 Types of Pavement Distress

Several types of pavement distress may be encountered in streets or highways. Determine the reason for the distress and take action to correct the condition that caused the trouble. Figure 100-1 shows the common types of asphalt pavement distress and candidate preventive maintenance treatments. Before pavement maintenance is performed, it is important to determine the cause(s) for each distressed area and to choose the right corrective action.

Some of the surface evidences of pavement distress are:

- Rutting
- Raveling
- Longitudinal or transverse cracks
- Alligator Cracks
- Potholes
- Bleeding and instability
- Depressions
- Edge breaking
- Frost heaving

Frequently, more than one pavement distress type is evident at the same time. One type of distress may progress to a more serious type or may progress to failure if corrective action is not taken. Refer to Figure 100-1 for the most appropriate corrective treatment for the distress type(s) present.

110.2 Asphalt Materials

Asphalt is refined from crude oil and is a product of the petroleum industry. At ambient temperatures, it is solid or semi-solid. To be used in maintenance operations, it must be made liquid enough to coat aggregate. Asphalt can be liquefied in three different ways: by heating (asphalt cement); by dissolving in a petroleum solvent (cutback asphalt); by combination with water (asphalt emulsion). The three general type of asphalt are described in the following subsections. To determine the most appropriate asphalt to use for a particular maintenance operation, consult with the District Maintenance, Regional, or Materials Engineer. The asphalt supplier can also be of assistance in determining the best asphalt product to use for a particular project.

Figure 100-1
FLEXIBLE PAVEMENT DISTRESSES AND CANDIDATE PREVENTIVE MAINTENANCE TREATMENTS

Category of Distress	Type of Distress	Potential Actions
Cracking	Fatigue cracking	Not a candidate for preventive maintenance
	Block cracking (low to moderate)	Thin cold treatment, chip seal, thin hot mix overlay
	Edge cracking	Crack treatment
	Longitudinal cracking	Crack treatment
	Reflection cracking at joints	Crack treatment
	Transverse cracking	Crack treatment
Patching and Potholes	Patch/patch deterioration	Extensively patched pavements are not good candidates for preventive maintenance
	Pot holes	Pot hole pavements are not good candidates for preventive maintenance
Surface Defects	Rutting • Densification of pavement	Fill ruts with micro-surfacing or strip chip seal, then thin cold treatment or chip seal
	• Unstable asphalt concrete	Preventive maintenance cannot repair problem
	Shoving	Unstable pavement is not a candidate for preventive maintenance
	Bleeding	Sand seal, chip seal, micro-surfacing
	Polished aggregate	Thin cold treatment, chip seal, thin hot mix overlay
	Raveling	Fog seal, thin cold treatment, chip seal, thin hot mix overlay

NOTE: Load-associated fatigue cracking of flexible pavements indicates a lack of structural capacity. Fatigue cracking develops in the wheel path in progressive stages.

110.2.1 Asphalt Cement

Asphalt cement is the basic material of the asphalt family. It is a semisolid material used in making hot mix asphalt, and can also be used for surface treatments, seal coats, and crack filling. Various grading systems are used to specify asphalt cement by its hardness, viscosity, and desired performance characteristics. Additives and/or modifiers can be combined with asphalt cement to change its properties.

110.2.2 Cutback Asphalt

Asphalts that are liquefied by blending with petroleum solvents are referred to as "cutbacks." When they are spread on the road or pavement, the solvent evaporates, leaving the asphalt cement behind. These asphalts are made according to curing time: rapid-curing (RC), containing a naphtha-like solvent, and medium-curing (MC), with a solvent similar to kerosene are the two most common types. A third type, sometimes referred to as "road oil," is slow-curing (SC) and uses heavy fuel oil as the solvent.

Each type of cutback is available in various viscosity-controlled grades ranging from Grade 70, which contains the most solvent and is the most fluid, to Grade 3000, which contains the least solvent and is least fluid.

110.2.3 Asphalt Emulsion

Asphalt emulsions are liquid mixtures of asphalt cement, water, and an emulsifying agent. In an asphalt emulsion, minute globules of asphalt are suspended in water by using an emulsifying agent. Asphalt emulsions are graded according to the time it takes for them to "break" or come out of suspension. The three most common grades are rapid-setting (RS), medium-setting (MS), and Slow-setting (SS). Asphalt emulsion usually has a dark brown color when the asphalt is in suspension that becomes black when the asphalt and water separate.

Asphalt emulsions come in two types: anionic and cationic. In the anionic type, the globules of asphalt have a negative electrical charge. In the cationic type, the globules are positively charged. These differences in electrical charge improve the coating and bonding properties of the emulsion when used with aggregates having oppositely charged surfaces.

As in the cutback grades, the lower numbered grades are the most fluid (Grade 1 is more fluid than Grade 2). The small letter h indicates that the base asphalt is a somewhat harder grade. The letter C indicates a cationic emulsion. Other designations, such as HF for high float and P for polymer modified are also being used. Emulsion technology is rapidly changing, with new variations being developed continually, consult with the Materials Engineer or the asphalt supplier for detailed information on the best product to use in particular situations.

111.0 HAND-PATCH POTHOLES

Potholes are breaks in the surface with the hole extending into or through the base.

> Repair these failures as soon as possible after their discovery, using one of the methods of repair listed below.

There are three common pothole patching techniques:

1. Throw-and-Roll
2. Semi-Permanent
3. Spray Injection

Each of these techniques has been shown to be effective under curtain conditions. Depending on the particular conditions, one method will usually be more cost-effective than the other.

111.1 Throw-and-Roll

This procedure consists of the following steps:

- Place the material into a pothole (which may or may not be filled with water or debris).
- Compact the patch using truck tires.
- Verify that the compacted mix has some crown (between 3.2 mm and 6.4 mm).
- Move to the next pothole.
- Open the repair to traffic as soon as maintenance workers are clear.

The throw-and-roll method is very cost effective for winter patching operations. For the best results in winter patching operations always use a high quality winter patching mix.

111.2 Semi-Permanent

This procedure is much more labor intensive then the throw-and-roll. However, this increased labor cost can sometimes be offset with increases in performance of the patches by improving the underlying and surrounding support provided for the patches. The semi-permanent repair method is considered one of the best for repairing potholes, short of full-depth removal and replacement. This procedure includes the following steps:

- Remove water and debris from the pothole.

- Square up the sides of the patch area until vertical sides exist in reasonably sound pavement.
- Place the mix.
- Compact with small vibratory equipment such as a single drum vibratory roller or vibratory plate compactor.
- Open the repair to traffic as soon as maintenance workers and equipment are clear.

This repair procedure provides a sound area for patches to be compacted against, and results in very tightly compacted patches. However, it requires more workers and equipment and has a lower productivity rate than either the throw-and-roll or the spray-injection procedure.

111.3 Spray Injection

The spray-injection procedure consists of the following steps:

- Blow water and debris from the pothole.
- Spray a tack coat of binder on the sides and bottom of the pothole.
- Blow asphalt and aggregate into the pothole.
- Cover the patched area with a layer of aggregate (optional).
- Open the repair to traffic as soon as maintenance workers and equipment are clear.

This procedure requires no compaction after the cover aggregate has been placed. This procedure has been shown to be one of the most cost-effective patching methods because of the high productivity and the durability of the patches. This method can only be used when temperatures are above freezing because of the CRS-2 emulsion that is typically used.

112.0 DEEP PATCH AND BASE REPAIR

Deep patch and base repair consists of removal and replacement of areas of bituminous roadway surface, including removal and replacement of base material if required; then placing premix to correct severe alligator cracking, upheavals, pothole clusters, and base failures. The recommended procedure is:

- Break out and remove unsuitable material, including contaminated base, at least one foot outside perimeter of the cracked area.
- Square up the sides of the patch area until vertical sides exist in reasonably sound pavement.

- Apply light and uniform tack coat of asphalt emulsion.
- Place the mix in layers not exceeding 75 mm in depth.
- Compact each layer with vibratory compactor equipment such as a single drum vibratory roller or vibratory plate compactor.
- Open the repair to traffic as soon as maintenance workers and equipment are clear.

113.0 OVERLAYS

A maintenance overlay consists of reconditioning old surfaces, overlay patching, or shallow leveling with plant mix or cold mix to correct surface deficiencies. This activity includes overlays and leveling courses less than 20 mm average thickness regardless of length, overlays and leveling courses of greater in depth but less than 150 m continuous length, and scrub coats of any continuous length. The general procedure is:

- Mark area to be leveled.
- Broom loose material from surface.
- Apply light but uniform covering of asphalt emulsion tack material.
- Spread mix using a grader, paving machine, or Montana Rut Filler; mix should be spread in layers no greater than 75 mm in thickness.
- Hand rake to feather edges where needed.
- Roll each layer immediately.
- Broom area to remove loose material from roadway surface.

Every effort should be made to achieve a smooth riding surface when applying maintenance overlays. Asphalt paving machines should be used whenever possible, as they achieve the most consistent results. Graders or the Montana Rut Filler equipment can be used on low volume highways and in emergency situations. The smoothness of the ride for maintenance overlays and patching is primarily dependent on the skill of the operator, therefore always use experienced operators when performing this operation. Training of operators is critical and each district should have a yearly training session.

114.0 SPOT SEALING

Apply asphalt and aggregate (see Chip Seal) to small areas of bituminous surfaces to correct raveling, spalling, shallow surface failures, restore skid resistance, and prevent further deterioration of the surface.

115.0 SURFACE TREATMENTS

Apply one or more layers of asphalt and aggregate to continuous sections of bituminous surfaces to seal cracks; restore skid resistance; correct flushing or bleeding; or rejuvenate dry, weathered surfaces, thereby preventing further deterioration of the surface.

115.1 Types of Surface Treatments

Fog Seal: A fog seal is a light application of 50/50 diluted asphalt emulsion shot at no more than 0.1 gal/sq. yd. without an aggregate cover. The emulsion is usually diluted with an equal amount of water and sprayed at a rate 0.45 to 0.70 liter/sq. meter of diluted material. Exact quantities depend on the surface texture, degree of dryness and amount of cracking of the pavement being fog sealed. Fog seals are used to:

- Renew asphalt surfaces.
- Seal small cracks and surface voids.
- Address raveling of chips and open-graded surfaces on high-volume roads.
- Maintain and delineate shoulders in high-volume roads.

Recommended on all blade patches.

Over-application must be avoided as this may result in asphalt pick-up by vehicles or reduced pavement friction. If over-application occurs, it is desirable to reduce traffic speed and to apply a light sand coat.

Sand Seal: A sand seal is an application of asphalt followed by a sand cover aggregate. The sand or stone screenings should be 6.35 mm sieve size or smaller. The binder used for sand seals is usually a rapid setting or a medium setting emulsion. A sand seal is essentially the same as chip seal except finer aggregates are used as cover. Sand seals are used to:

- Improve microtexture and provide better surface friction.
- Retard aging of asphalt surfaces.
- Seal small cracks and surface voids.
- Address raveling of chip seals and open-graded surfaces.

Chip Seal: A chip seal consists of liquid asphalt covered with an approved cover coat material. Asphalt may be rapid- or medium-curing liquid asphalt or emulsion. Chip seals typically provide 4 to 7 years of good performance on highways with as much as 5,000 vehicles per day. Studies have shown that the timing of chip seal applications relative to the existing pavement condition is critical. Chip seals are used to:

- Provide better surface friction.
- Retard aging of asphalt surfaces.

- Seal small cracks and surface voids.

Slurry Seal: A slurry seal is a mixture of asphalt emulsion, well-graded fine aggregate (sand) and mineral filler mixed with water to produce slurry consistency. Slurry seals are used to:

- Seal minor surface cracks and voids.
- Retarding surface raveling.
- Improve surface friction characteristics.

Microsurfacing: Microsurfacing can be viewed as a polymer-modified cold paving slurry seal system. Microsurfacing cures faster and develops strength faster and can be placed in a thicker layer than the slurry seal. Microsurfacing can be used for texturing, sealing and rut filling. Microsurfacing can provide a long-term solution for ruts if the pavement is stable. Other uses of microsurfacing include:

- Application on oxidized, raveled and flushed surfaces.
- Crack and void filling.
- Minor leveling.
- As an interlayer.
- Bridge decks.

115.2 Procedure

Seal coats for overlays or new plantmix pavements are recommended to be placed on the pavement surface 3 or 4 years after completion. After initial application, maintenance seal coats should be done on approximately a seven-year cycle. However, as the pavement ages, each pavement should be evaluated and the most cost effective maintenance or rehabilitation strategies should be used based on the distresses present.

For more information on seal coating see Section 403 of the ITD Standard Specifications, the Materials Manual, and Administrative Policy A-05-01.

117.0 CRACK SEALING

Crack sealing of flexible pavements is a routine maintenance activity that basically involves cleaning and filling cracks with a liquid sealant. Crack sealing can prolong the life of flexible pavements by preventing or reducing intrusion of water and incompressible materials from entering the pavement and base.

To be cost-effective, crack sealing must be done at the proper time in a pavements life. Typically if a pavement has low to moderate density of cracks and the cracks show moderate to no deterioration at the edges, crack sealing is an appropriate maintenance procedure. However, if the cracks are very wide (greater then 30 mm) then an alternative maintenance strategy should be used, such as partial depth patching or spot patching.

It is important to understand the difference between crack filling and crack sealing. Crack sealing is the placement of specialized materials either above or into working cracks to prevent the intrusion of water and incompressible materials into the crack. Crack filling is the placement of materials into nonworking cracks to substantially reduce infiltration of water and to preserve the pavement. Working cracks refers to horizontal and/or vertical crack movements greater than 3 mm throughout a year.

Small to medium width cracks (6 to 25 mm) are the best candidates for crack sealing. Cracks smaller then 6 mm may be better handled by some kind of surface treatment, such as a seal coat or slurry seal. Cracks larger then 25 mm and that are spalling may need to be repaired by patching.

117.1 Procedure

If needed, rout out the crack to the sealant manufacture's specifications for width to depth ratio. Clean the crack using high-pressure air, sandblasting, wire brushing or hot air blasting. This is a key step to crack sealing. If the crack is not thoroughly cleaned the sealant will not adhere to the sides. Hot air blasting is the preferred method because it helps dry the crack and if the sealing operation closely follows the hot air drying, the heated crack surface helps the sealant adhere to the crack. After cleaning the crack, sealant should be applied from bottom to the top of the crack to prevent air bubbles from forming and creating a weak spot in the sealant. Fill the crack to at or near the top, use a squeegee to remove any excess sealant on the pavement surface. Excess sealant on the pavement surface is to be avoided. Finally, use a blotter such as toilet paper or sand placed directly on top of the sealant to prevent tracking.

117.2 Materials

Refer to sealant manufacture's recommendations for the proper material to use based on climatic and temperature ranges in your area.

118.0 ENVIRONMENTAL PROTECTION

Years ago diesel was the product used to clean and pretreat equipment when working with bituminous pavement. With environmental regulations now in place, we are no longer allowed to dump or spill diesel and asphalt. The following policy is the best known management practice when asphalt cleaning is necessary.

118.1 Asphalt Equipment Procedure

Pretreat all grader blades, truck beds, tires, asphalt distributors, or other equipment and tools with vegetable oil or other approved proprietary product as a release agent for asphalt. You can use hand sprayers to apply vegetable oil.

118.1.1 Truck Beds

Spray the beds down with vegetable oil after each load using just a thin stream at the top of the bed, it will run down and coat the entire side, then put one coat on the floor. Spray once as needed.

At the end of the day there may be some mix on the tail gate, spray a thin bead around the top; the next day the mix should remain soft and come off with the first load.

118.1.2 Grader Blades

Spray vegetable oil on the grader blades once a day or as needed.

118.1.3 Asphalt Distributor

Spray it down with the vegetable oil during the day, then clean it with a citrus based cleaner in the evening only as needed.

118.1.4 Asphalt Distributor Bar

The asphalt distributor bar may need to be coated with vegetable oil after every spray.

118.1.5 Hand Tools

Using vegetable oil on tools such as rakes and shovels works well, the mix does not build up on them, and what does remain can be easily tapped off.

118.2 Asphalt Distributor Bar Cleaning

When cleaning the distributor bar, always catch any diesel or asphalt. You may want to use a tray and recycle the diesel or asphalt into the tank, then reverse the pump to clean out the piping and snivies or reverse the pump to suck all the asphalt and diesel back into the tank. Consult the asphalt distributor's operations manual for the correct method to reverse suction.

131.0 REPAIR CONCRETE PAVEMENTS

Replace broken areas or utility cuts with concrete so that the patch will be equal in strength and riding quality, and similar in appearance to the remainder of the pavement.

Patching should be done as soon as possible. If delayed, the broken area may become enlarged by action of traffic. Temporary measures, such as covering the broken areas with bituminous mixture, do little toward restoring the pavement strength. However, temporary measures should be considered in emergency cases.

A "broken area" refers to portions of the pavement which are broken into pieces too small to distribute the load to the subgrade without imposing unit pressures greater than the safe carrying capacity of the subgrade. Under this condition, the broken portions of the slab become displaced and their surface is no longer in the plane of the rest of the pavement.

Concrete patches are easily placed. If the patch is properly done, it becomes an integral part of the pavement which is restored to its full serviceability.

131.1 Design of Patch (Size and Shape)

The patch's shape, size, and position in the pavement with respect to joints and edges have a direct relation to its ability to stand up under traffic. When laying out the patch, consider the existing pavement condition and the shape and dimensions which will provide the best performance.

Design details for patches are classified into five types according to the position of the patch in the pavement:

- Full-width patch, involving all lanes of the pavement. These patches are usually constructed one lane at a time.
- Single-lane patch, involving the width of a single traffic lane.
- Exterior-edge patch. This is a patch less than a full lane in width, an edge of which lies along the outside edge of the pavement.
- Interior-edge patch. This is a patch less than one full lane in width, one edge of which lies along an interior edge or joint of the pavement. This edge may be unprotected (butt construction joint with neither dowels nor tongue and groove to provide load transference). If the joint is the center joint of a pavement built in two-lane widths, it will be protected with load transference in the form of aggregate interlock or a deformed metal plate.
- Interior patches, with all edges at least two feet distance from any longitudinal or transverse edge or joint. These patches are not the result of breakage of the pavement in service but are due to cuts made to gain access to a utility under the slab.

Figures 100-2 and 100-3 illustrate these five types of patches and their location in the slab with respect to edges and joints. When the patch is at an expansion joint, the minimum length of patch is 6 feet. If there is a breakage at both sides of the expansion joint, the total minimum length becomes 12 feet unless the patch extends the full width of the pavement. In this case, the expansion joint may be omitted in the patch except at location next to bridges or other structures. Align expansion joints in single-lane patches with the joint in adjacent lanes.

Patches are usually rectangular in shape, as shown in the drawing, but triangular or diamond-shaped patches have been used with success to repair broken slab corners which are not on the exterior edge of the pavement. The sides of the triangle or diamond make angles with the longitudinal edge of the slab which must be not less than 30 deg.

131.1.1 Undercut Method of Load Transfer

To transfer the live load from the existing slab to the newly placed repair, an undercut is required where no dowel bars exist. A small excavation under the existing slab will allow for 6 inches of additional concrete depth and 6 inches of intrusion under the slab. This shall be filled with new concrete when the new slab is poured (see Figure 100-4). This method is used when no dowel bars exist to transfer loads from slab to slab.

131.2 Pavement Thickness

It is practical to patch if the existing pavement is generally adequate for the loads that it is to carry. Otherwise, consider reconstruction or resurfacing instead.

Remove and replace local unsatisfactory subgrade before placement of patches. Use the patch thickness shown in the following table:

RECOMMENDED THICKNESS OF PATCHES

Design of Existing Pavement	Depth of Patch (D in Fig. 100-3)
A. Thickened-edge slab	1. D=1.3 times center thickness of original slab on all patches involving unprotected corners. 2. D=1.2 times center thickness of original slab on all patches not involving unprotected corners.
B. Uniform-thickness slab with dowels or other load transfer devices at expansion joints.	1. D=1.1 times original slab thickness for all patches involving unprotected corners. 2. D=same depth as existing slab for all patches not involving unprotected corners.
C. Uniform-thickness slab without load transfer devices at expansion joints.	1. D=same depth as existing slabs for all patches.

Figure 100-2

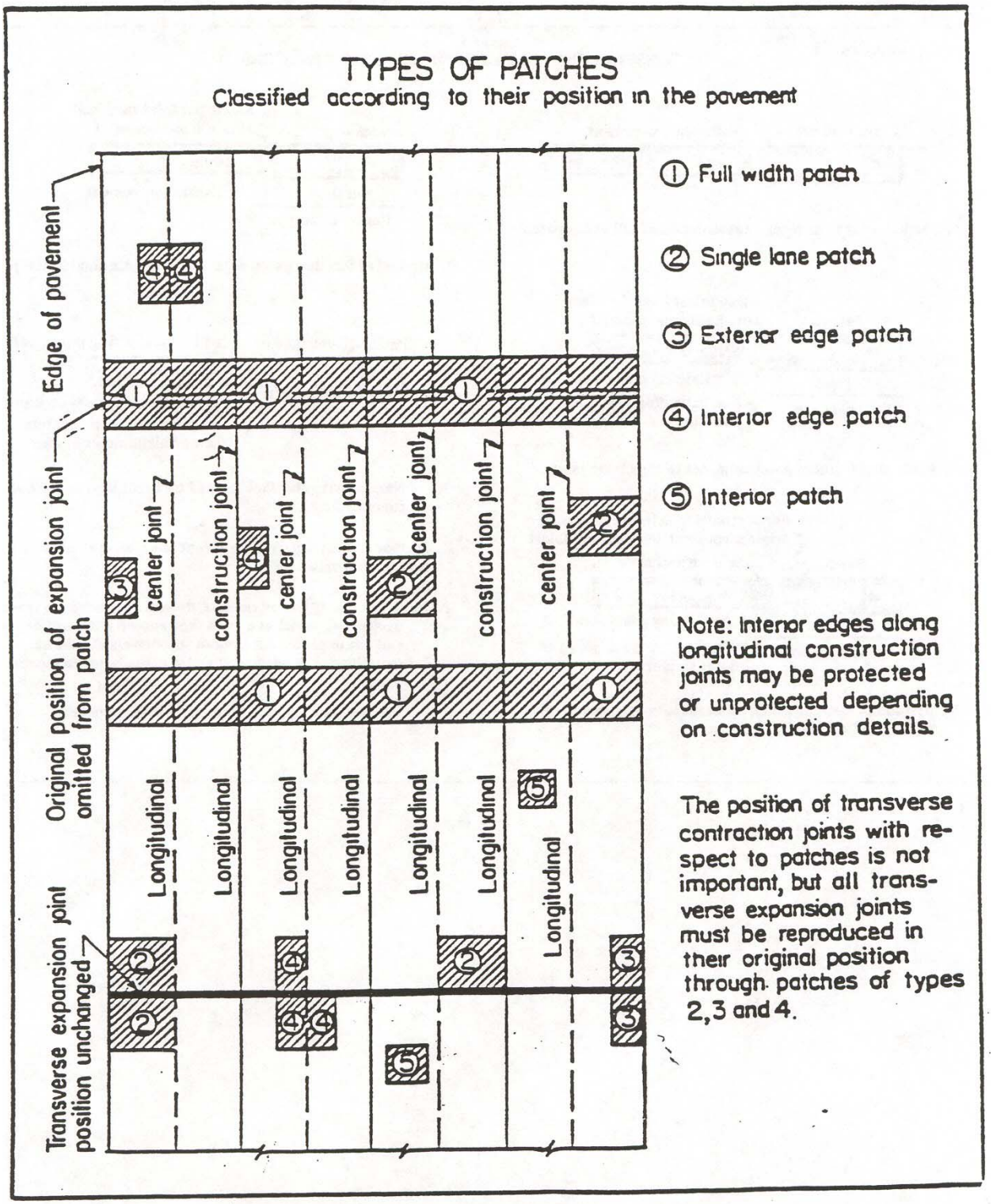
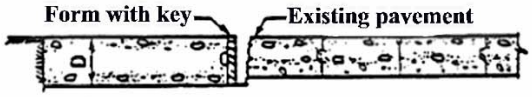
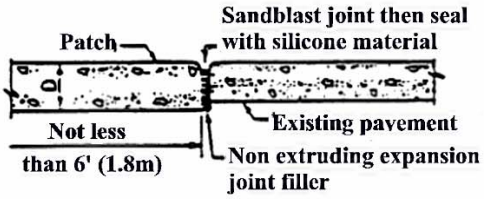

TYPES OF PATCHES
Classified according to their position in the pavement
Edge of pavement
Original position of expansion joint omitted from patch
Transverse expansion joint position unchanged
center joint
construction joint
Longitudinal
① Full width patch
② Single lane patch
③ Exterior edge patch
④ Interior edge patch
⑤ Interior patch
Note: Interior edges along longitudinal construction joints may be protected or unprotected depending on construction details.
The position of transverse contraction joints with respect to patches is not important, but all transverse expansion joints must be reproduced in their original position through patches of types 2,3 and 4.

Figure 100-3

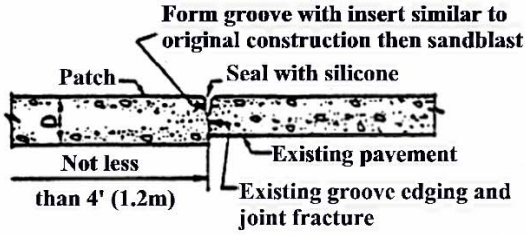
CONSTRUCTION DETAILS FOR CONCRETE PATCHES



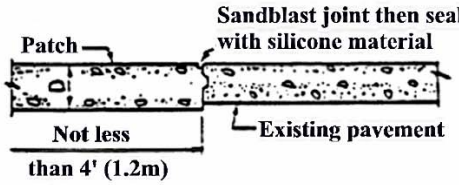
A. Method of lane-at-a-time construction of full width patch



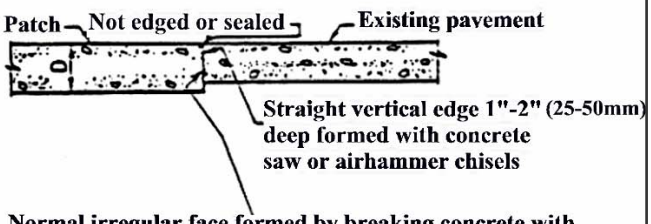
B. Method of forming patch adjacent to expansion joint



C. Method of forming patch adjacent to contraction joint or longitudinal dummy groove



D. Method of forming patch adjacent to longitudinal keyed joint

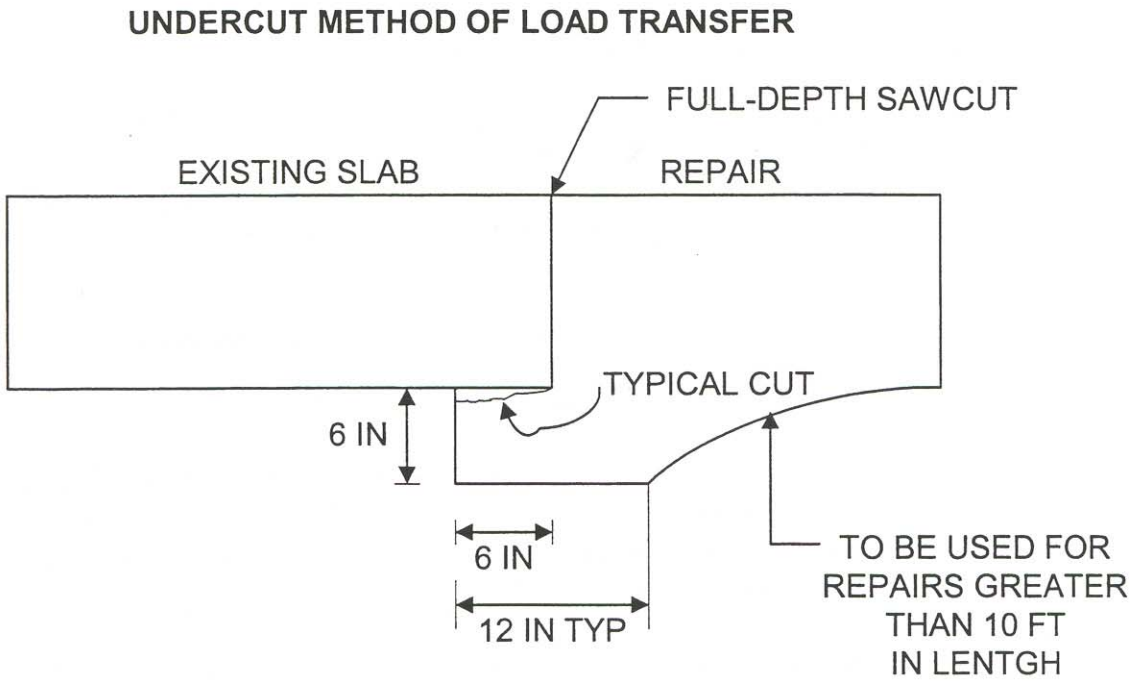


E. Method of forming patch adjacent to existing concrete where no joint is located

Note: Wherever tiebar or tiebolts, dowels or other load transfer devices are found in a joint the exposed ends will be cleaned and left in place. All smooth slip dowels should be straightened, if necessary and greased prior to placing the patch.

Interior patches have no minimum dimensions

Figure 100-4



131.3 Joints

Various types of joints are explained in the following subsections.

131.3.1 Longitudinal Center Joints

Whether or not longitudinal center joints were used in the original construction, use them in full-width patches in street and highway pavements, since it is usually necessary to build the patch one lane at a time to accommodate traffic. In constructing the first half-width, break out enough of the second lane to permit the placement of forms. Keep the new pavement in the first lane completely separated from the broken pavement in the second land to avoid traffic vibration of the fresh concrete. If the patch is constructed in two-lane widths, use a weakened-type of longitudinal center joint. This may be a dummy groove formed at the time of construction or cut with a concrete saw after the concrete has hardened.

In single-lane patches or interior edge patches, thoroughly clean the face of the joint and place the new concrete against it. Projecting tiebars are left in place unless the pavement in the next lane is also being replaced. Finish the edge of the patch next to

the longitudinal joint with a concrete edger and leave a groove to permit sealing after completion of the patch.

131.3.2 Transverse Expansion Joints

Unless the patch extends the full pavement width, any expansion joint that existed in the original pavement must be replaced in the patch at its original position. As stated before, dowels are not required. They may be used, but the recommended pavement thickness will result in a pavement that is adequate without them.

When the patch extends the full width of the pavement, do not replace an expansion joint unless it is apparent that additional expansion space is needed. If a joint appears to be needed, place it at any location within the patch more than 1.8 m (6 feet) from each end of the patch. It is not necessary to place it at the same location as the original joint.

The joint is sealed as described in Section 132, Joint Filling.

131.3.3 Transverse Contraction Joints

Install contraction joints to form slab lengths of 3.6 to 5.5 m (12 to 18 feet) in all full-width patches of 5.5 m (18 feet) or more in length. For other than full-width patches, the location and spacing of contraction joints should agree with jointing arrangement in the original slab.

Use dummy-groove contraction joints of a depth equal to one-fourth the depth of the patch. The groove may be formed during construction or may be cut with a concrete saw immediately after the concrete has hardened sufficiently to permit this operation.

Contraction joints may be built without dowels and should be sealed as described in Section 132, Joint Filling.

131.4 Preparing for the Patch

The procedure is explained in the following subsections.

131.4.1 Subgrade Support Adjacent to Patch

If breakage has been caused by pumping action, it may be desirable to improve the subgrade support for the pavement adjacent to the areas to be patched before proceeding with the repair. This may be done by pumping a slurry of cement and sand under the pavement. Another method is to use URATEK expanding foam (see Section 133.0, Slab Jacking).

131.4.2 Removing Old Pavement

Before removing the old concrete, outline the area to be patched for either replacement or surface cuts on the pavement. Make a cut with a concrete saw along all edges not bounded by joints. This cut should be 38 to 51 mm (1 1/2 to 2 inches)

deep to ensure a straight vertical edge for the upper portion of the patch. This will prevent overhang and irregular feathered edges of the concrete patch, which often spall under traffic.

After all edges have been cut, break the area to be patched into small pieces and remove them. Usually, the edges of the patch below the saw cut are broken by using pneumatic chisels or drills. Leave the broken edge below the saw cut fairly rough and irregular, but in approximately vertical planes so that it will provide aggregate interlock between the patch and the existing pavement. This acts as load transference, restricts differential movement under loads and prevent faulting. Avoid acute angles in the patches and the old pavement. Except for the triangle- or diamond-shaped patch, edges of the patch are usually parallel or at right angles to the centerline and edges of the original construction.

Hand methods for removing the old pavement are sometimes used where the patches are few in number and small in area, or widely separated.

If patching large areas within a relatively small radius, use power equipment to save money and time. Break the portion of slab to be removed into one-man blocks. Load the blocks of concrete into trucks or pile them along the edge of the pavement for removal.

Saw cut and lift out slabs with equipment in as large of sections as possible. Before placing new concrete, clean the edge of the old slab to be sure it is free from dust, dirt, or portions of concrete which have been broken loose and have not been removed. When the new concrete is placed, paint the edge of the old slab with a thin concrete latex bonder (moose milk).

131.4.3 Preparation of Subgrade

Frequently, pavement breakage is caused by a local condition of the subgrade, such as frost boils or frost heave, seepage from a water-bearing layer of soil, or a number of other conditions.

Correct these conditions before patching to avoid repeated breakup.

Correct poor drainage by installing suitable drains to intercept the water or lower the water table as required. Remove unsatisfactory subgrade material and replace with new compacted material in layers of proper thickness. If the existing subgrade is susceptible to pumping and if the pavement shows evidence of pumping, consider using a geo-grid fabric under the base course under the patch. For large patches, granular subbases approximately 1 foot (305 mm) thick and approximately 1 foot (305 mm) wider than the pavement may be used. Carefully compact the subbases with hand or pneumatic tools. Provide drainage if the subbase material is open graded, but not if it is dense-graded material. In all cases, whether the subgrade material is new or old, the soil should be damp, but not wet, before the new concrete is placed.

131.5 Placing of Concrete

The procedure is explained in the following subsections.

131.5.1 Concrete Materials and Proportions

Select good quality patching and curing materials to comply with specifications for concrete pavement as outlined in Idaho's Standard Spec. Book. A dry, low slump concrete gives the best results in patching. The mixture should contain only enough moisture to allow finishing. Never add water to the surface during finishing operations.

When using large amounts of concrete (greater than 5 cubic yards), check with the District Materials Engineer for assistance with mix designs and source approvals.

To open the patch earlier to traffic, a mixture that will give a higher early strength than mixtures used in regular construction work can be used. In traffic emergencies, they may be opened earlier if possible damage to an occasional patch is justifiable.

131.5.2 High Early-Strength Concrete

There are several methods of producing high early-strength concrete, including:

- Use of low water-cement ratios. Practically, low water-cement ratios mean richer mixtures in order to obtain the required workability. However, concrete for patches should be mixed as dry as can be properly placed, compacted and finished.
- Use of high early-strength Portland cement (Types III or IIIA).
- Use of a plasticizer or water reducer chemical additive.

131.5.3 Use of Air-Entrained Concrete

Patching is frequently necessary in areas where severe frost action prevails or where salts or granular materials impregnated with salts are used to remove ice from the pavement. Unless air-entrained concrete is used, the surface of a patch may scale under these severe exposure conditions. Air-entrained concrete is highly resistant to the destructive action of frost and salt applications, providing the materials (sand, coarse aggregate and water) used in the mix are of good quality and the concrete is properly mixed, placed and cured.

Air-entrained concrete does not add to the cost or complicate patching operations. The same cement content per unit volume is maintained for air-entrained concrete as is used with normal paving mixtures, and the mixing time remains the same. The fresh air-entrained concrete has a fatty appearance, is cohesive and somewhat sticky, but may be handled, screeded and finished with ease. The workability of the concrete is much better than that of nonair-entrained mixes. In many cases, this improved workability allows the water content to be reduced without impairing the

placeability. As a result, there is little free water on the surface for lubrication during finishing operations. The absence of free water is more critical during hot, dry or windy weather. This condition is not objectionable as it permits finishing almost immediately after screeding. Early protection and curing are thus made possible at the critical time when the concrete is in need of this protection.

Always use air-entrained concrete for patching concrete pavements that are subjected to severe frost action or where the repeated application of sodium chloride, calcium chloride, magnesium chloride, or granular materials impregnated with these salts is anticipated. Air entrainment can be produced by using air-entrained Portland cement complying with ASTM specification C175, or by incorporating air-entraining agents which comply with ASTM specification C233 at the mixer. Several air-entraining agents are available which comply with this specification.

If there are any questions on mix designs or admixtures, please contact the District Materials or Headquarters Pavement Engineer for assistance.

131.5.4 Mixing and Placing

Concrete will be more uniformly and accurately proportioned if materials for each batch (except water) are measured by weight. Water is measured by volume or weight. Small portable scales are available for use where a central proportioning plant is not used. Check and calibrate the equipment. To obtain the correct net amount of water to add per sack of cement, reduce the amount by the amount of free water in the aggregate or increase it by the amount of water that will be absorbed by dry aggregates.

On small, isolated patches the measurement of materials by volume is permitted. In this case, carefully calibrate the measuring hoppers allowing for bulking of fine aggregate due to varying moisture content. In proportioning by volume, a 94 lb. (42.6 kg) sack of cement is considered as 1 cu. ft. (0.03 m^3).

Except for small isolated patches, machine-mix the concrete for at least one minute. Ready-mixed concrete may be used if it can be placed and finished without adding more water. Whenever possible, ready-mix concrete should be used to ensure high quality results.

Before the concrete is placed, dampen the edge of the old concrete and the subgrade, and paint with a concrete latex bonder; then fill the space with concrete. Concrete shrinks slightly as it hardens, therefore, minimize shrinking by using a vibrator or tamping the concrete after placement.

When concrete is first placed, it is struck-off and vibrated or tamped at an elevation slightly higher than the intended finished surface of the patch. Use mechanical vibrating equipment especially at the edges of the patch, to consolidate the freshly placed concrete. Screed the concrete surface, then check with a straightedge to give the same contour as the old pavement.

131.5.5 Finishing

When patches are finished, they should have (as nearly as possible) the same surface texture as that of the adjacent old concrete. Finish the patch with a canvass, a wood-float, a burlap drag or a broom to correspond with existing pavement. Do not add water to the surface to aid in finishing. Working of the surface should be kept to a minimum.

All transverse and longitudinal joints and outside edges of the pavement which are part of the patch should be edged with an edging tool having a radius of 3 mm (1/8 inch). Do not edge a patch where it joins a broken edge of the old pavement.

131.5.6 Curing

The size and scattered locations of concrete patches makes it inconvenient to use a curing method involving frequent moisture throughout the curing period.

Other acceptable curing materials requiring little or no water are:

- Curing membranes directly on the newly finished patch to completely cover all exposed surfaces. Place impervious paper as soon as the concrete is hard enough so that it will not be marred. Thoroughly wet the pavement before placing the paper. No further application of water is required. Curing should be continued until the patch is ready to be opened to traffic. Care should be taken to ensure the paper is not blown off by wind or traffic.

- Spraying on curing membranes that are applied directly on the finished patch immediately after the surface treatment is completed.

132.0 JOINT FILLING

Sealing joints and cracks prevent surface water seepage through the pavement openings, excludes foreign matter, and preserves the original joint filler, if any, which tends to deteriorate and become inert if not protected. Keep moisture in the subgrade below the free water stage by all feasible means to prevent pumping at joints, cracks and to avoid damage from frost action in cold climates. Incompressible foreign matter in joints and cracks may cause spalling during pavement expansion. Hot pour sealers are not to be used in new construction. Silicone and compression seals are preferred methods of sealing all concrete joints.

132.1 Expansion Joints

Expansion joints are usually transverse joints, although extremely wide pavement may have one or more longitudinal expansion joints. From a maintenance standpoint, longitudinal and transverse expansion joints require similar treatment.

The type of filler and sealing material used in constructing the joints has a direct influence on methods and materials used in maintenance.

Expansion joints may contain a filler which either compresses or extrudes as the concrete expands. In older pavement, the material used for filling expansion joints was almost always a relatively noncompressible material such as asphalt or tar. When the concrete expanded, the filler forced out of the joint, creating an objectionable "bump" on the pavement. Newer pavements contain nonextruding fillers. Almost all expansion joints the maintenance man deals with today have nonextruding fillers.

132.2 Maintenance of Nonextruding Expansion Joints

Replacement of the nonextruding filler is sometimes required. The top of the filler is usually at a sufficient depth (1/8 inch or more) below the surface of the pavement.

Maintenance of polymerized asphalt joints usually involves replenishing or replacing the seal material. Add a small amount of sealing material to keep the joint well sealed if the old sealing material is of good quality. Replace the sealing material if the old material has become brittle or "dead" and no longer adheres to the concrete and top of the joint, a condition caused by evaporation of volatile oils, by oxidation, or by other chemical or physical changes in the sealing material. Loss of resiliency also may be caused by overheating the sealing material at the time it was placed. If the joint is partially filled with foreign material, such as sand and gravel, replace the old seal.

Silicone joint filler is the preferred method on all concrete joints, but the proper installation is essential to providing a long lasting seal. All existing material must be removed from the joint either by routing or sand blasting. While sand blasting, pay particular attention to the walls of the joint to remove all dirt and foreign mater and provide a clean surface for the silicone material. This cleaning process must remove

all material down to a depth of three (3) inches from the roadway surface. A closed cell backer rod must be installed into the freshly cleaned joint. The size of the backer rod is 1.25 times the width of the open joint. The backer rod must be placed at a depth of 1 inch and not over 1 1/8 inches from the roadway surface. The silicone is a one-part moisture cure silicone that is poured into the joint to a depth of 1/2 inch and not greater than 5/8 inch over the backer rod. Do not allow traffic to return to the roadway until the silicone has formed a crust to prevent contamination from roadway debris (usually one hour at 70ºF).

Do not delay replacement until the old seal has disappeared. Inspect the joints occasionally and replace hard, lifeless seals or seals that have lost their bond to the joint edge. Resealing of joints is not a seasonal operation; it should be done as the need becomes apparent. In the spring and fall, however, inspect joints to see if they need resealing. Make a special effort to get all joints sealed before winter weather. Best results in joint and crack sealing are obtained when the pavement contraction is at or near the maximum and the opening at joints and cracks is relatively large.

In replacing sealing material, remove the old dead seal so that the new material will have a good bond. Use stiff fiber or steel brooms and bars shaped to fit the joint space. Power-driven rotary cutters remove old sealing material and foreign matter and simultaneously roughen the sidewalls of the joint to ensure a good bond with the new seal. Sandblast joints to provide a clean surface for new joint material whenever possible.

When joints require replenishing of the sealing material, but not replacement, remove only loose and foreign material from the joint before resealing, using hand brooms or stiff fiber or steel bristles. Better results are obtained by using power-driven brushes which do this work rapidly at low cost.

When the concrete is dry and the joints have been thoroughly cleaned, they are ready for sealing. Use compressed air to blow out and dry the joint before sealing.

Use just enough sealing material to fill the joint within 1/8 inch of the surface. Overfilling is wasteful and causes an unsightly stripe across the pavement. Traffic can also pull joint material out of overfilled joints. A little experience in placement will show the correct amount of sealing material to use. Hot-poured material used to fill deep joints may shrink perceptibly while cooling. When it does, add additional sealing material.

Keep traffic off the pavement until the joint material takes its initial set (usually within one hour).

132.3 Contraction Joints

There are several types of contraction joints. The dummy-groove joint, consists of a surface groove about 3 to 10 mm (1/8 to 3/8 inch) wide and 38 to 101 mm (1 1/2 to 4 inches) deep, filled with a joint sealing material. The groove was formed while the

concrete was still workable, or was cut in the hardened pavement with a concrete saw.

Many pavements have been built with contraction joints formed by inserting premolded strips or ribbons in the freshly placed concrete. The strip in this type of weakened-plane joint varies from 2 to 6 mm (1/16 to 1/4 inch) wide and 51 to 101 mm (2 to 4 inches) deep. These strips are placed flush with the pavement surface or slightly buried so there is no visible evidence except for surface cracks.

The hand-formed groove with a poured seal is easy to maintain. If the original sealing material was of good quality, and if it was not burned or damaged when it was placed, remove only loose or foreign material in the joint groove. Clean the joint and add sealing material. Avoid overfilling.

When the original seal requires replacement, it may be "plowed out," using the same technique and resealing method described for expansion joints.

Sawed joints are sealed in the same way as formed dummy-groove joints except that special equipment may be necessary because of the unusually narrow opening. Power-driven rotary brooms are probably more satisfactory than hand brooms for cleaning when brooming is necessary. Satisfactory results may also be attained by using compressed air forced through a small nozzle.

Premolded strip or ribbon contraction joints normally require little or no maintenance for several years after construction. Do not seal the crack above a buried joint unless a groove is cut in the surface. Sealing material poured on the surface over a relatively narrow crack will not be an effective seal, but will create an unsightly bump on the pavement.

132.4 Longitudinal Center Joints and Construction Joints

Almost all paving equipment is built to construct lanes up to 11.5 m (38 feet) wide, but longitudinal center joints are constructed to produce lanes 3 to 4 m (10 to 14 feet) wide. These center joints are usually one of the types described above for contraction joints and are maintained in the same manner.

132.5 Cracks

Unless the crack is open in excess of 6 mm (1/4 inch) to permit the ready entry of sealing material, do not attempt to seal it. Sealing material applied to the pavement surface over narrow cracks is not effective and is likely to be removed by traffic. Much effort and material are wasted and unsightly conditions are created by attempts to seal hair cracks.

Clean wide cracks before sealing, sandblasting the crack if possible. Where compressed air is available, blow out the crack. Power-driven rotary brushes can also be used to remove all dirt and other inert material. In cases where cracks are open and seals are difficult to maintain, make a groove about 25 mm (1 inch) deep and less

than 13 mm (1/2 inch) wide along the crack with a rotary grooving device or plow to provide a recess for sealing material.

132.6 Sealing Materials

Various types of sealing material are available. Improved products are constantly being placed on the market and recommendations should be sought from both the Materials and Research Sections.

133.0 SLAB JACKING

Slab jacking satisfactorily and economically raises concrete slabs and corrects surface irregularities caused by settlement of the subgrade or errors in original construction. This method is used to improve riding qualities of the pavement, reduce impact resulting from fast-moving traffic over the irregularities or correct faulty drainage in paved areas which have settled so that water does not drain properly.

This method is sometimes used for the correction of subgrade conditions which result in pumping at a transverse joint. Slab jacking should fill all cavities under the slabs of a pumping pavement and reseat the slab on a uniform base. Slab jacking consists of drilling holes through the pavement, and pumping grout or other approved material under the pavement through the holes until all cavities are filled and the slab is raised to the desired elevation.

After the jacking is finished, clean the holes and fill with concrete mortar having a 1:3 mix. Be careful to prevent pyramiding of the grout under the slab near the hole. The jacking operation should raise the slab slowly with uniform pressure, filling all cavities to provide uniform bearing. In order to accomplish this, holes must be drilled close enough to permit the lifting medium to flow properly under the slab. If the lifting medium is pumped too fast, the slab may be cracked by pyramiding action. The actual speed depends on the thickness of the slurry. A heavy grout should not be pumped at more than 0.03 m^3/minute (1 cu. ft./minute) while an average grout flows freely under the slab at about 0.08 m^3/ minute (3 cu. ft./minute). When jacking is done to fill voids, continue to pump in one hole until the slurry shows in adjacent holes. This method assures complete filling of all voids.

A sand-cement grout with about 20 percent cement and a fine sand will pump readily and develop adequate strength. This type of grout develops a measurable compressive strength, thereby reducing cracking of slabs after jacking.

Another alternative to grout jacking is using URETEK expanding foam. This proprietary product uses an ethafoam-type material that when pumped under the concrete slab attempts to expand up to fifteen times its original volume. This expanding pressure lifts the concrete slab to its desired elevation. The foam hardens and becomes stable in approximately 20 minutes. At that time, traffic can be allowed across the slabs.

Careless or unnecessary jacking does more harm than good. Jack only when necessary to raise slabs that interfere with surface drainage, create a bad bump, or where pumping is serious enough to require correction. Jacking does not strengthen a pavement; it disturbs the subgrade and serves no purpose where no voids exist and no change in elevation is required. It may cause cracking of the slab.

When it is properly used, slab jacking provides a convenient, efficient, and economical means of raising concrete pavement slabs. The cost depends on the amount of lifting medium required to fill voids in the subgrade before lifting starts, the distance the pavement is to be raised, the area of pavement involved, and other local conditions. Proper jacking at the proper times is the best way to avoid pavement deterioration and expensive replacement.

136.0 SHALLOW CONCRETE PAVEMENT REPAIR

The method for repairing spalling concrete depends upon the size of the restoration.

If the area to be restored is small, 2 to 3 feet in width and less than 9 square meters in size, a quick-set concrete mortar should be used to make the repair. First using a concrete saw, make a vertical cut just beyond the limits of the spall or delamination. The saw cut should be 13 mm to 19 mm in depth. This provides a smooth, vertical face for the edge of the patch. Break out the concrete in the area to be repaired with a pneumatic chipping gun (14 kg gun maximum). If reinforcing steel is present in the repair area, the concrete should be removed to 19 mm below the rebar. Sandblast the entire area, removing all loose concrete and cleaning the reinforcing steel of all oxidation.

Mix an approved quick-set mortar such as Master Builders' **Set 45**, Eucolid Concrete Company's **Eucospeed MP**, or Sika's **122 plus**. Follow the manufacturer's recommendations closely. Pay particular attention to the water being added, as a very limited amount of water is necessary to hydrate all the cement in each bag. Too much water can result in premature failure of the patching material. Mixing should be done in a paddle wheel grout mixer for best results. Additional clean 9 mm pea gravel can be added to the mix (up to 50% by volume) to extend the patching material and give it strength and wearing resistance. Moisten the surface of the hole to be patched with water just prior to pouring patching material. The bottom and sides of the patch area should be moist, but with no standing water. Pour in the thoroughly mixed patching material and tamp vigorously into all areas of the void. Strike off the patching material to a level even or slightly higher than the adjacent roadway. Most quick-set patching materials are self-leveling. Shortly after hydration begins, the material may run slightly to the lower edge of the patch if repair is done on a roadway with a steep cross slope.

Minimal finishing is required with most pre-packaged patching materials. Smooth the patch with magnesium trowel or wood float. Let stand for required curing time, normally one to two hours, before allowing traffic over the patched areas.

All patches of this nature should be excavated and sandblasted prior to 2:00 p.m. to allow time for pouring, finishing, and curing of concrete during the same working day. This will prevent the need for nighttime traffic control. In areas with rush hour traffic, times should be adjusted to ensure opening prior to rush hour.

If the area is larger than 9 square meters in size, a normal transit mixed concrete should be used to patch spalled or delaminated concrete roadways. Recognize that transit mix concrete is substantially less expensive than the pre-packaged concrete repair materials, but it will require extended curing time (up to three days) before the patched area is opened to traffic.

Using a concrete saw, make a vertical cut around the entire area to be removed similar to the procedure outlined above. Remove all damaged, delaminated or spalled concrete within the patch area. If reinforcing steel is found inside the area to be patched, remove the concrete to 19 mm below the rebar.

When damage is at or near the full depth of the slab, a full depth repair may be required. In this case, stabilize the base material and compact any areas disturbed by the excavation of the repair. To assist in transfer of wheel loads from the existing slabs to the new repair, one of two methods must be performed:

- Option 1: Drill and install 9 mm x 432 mm rebar dowels at the mid-depth of the adjacent concrete slabs 576 mm on center around the entire patch. Dowels should be drilled and set to a depth of 216 mm into the existing slabs. Do not set dowels in areas where the edge of the patch is an expansion joint.

- Option 2: Excavate an area 216 mm in depth and 288 mm in width under the adjacent slabs. This is to provide for new concrete to flow under adjacent slabs and help in load transfer of traffic wheel pressures. Do not excavate the area along edges of the repair with expansion joints.

Transit mixed concrete should be ordered with Type III cement and an additive to provide for 6% ± 1% air entrainment. Several options of additional additives are available that can reduce the curing time of the concrete. Consult your Materials Engineer for approved concrete mix designs and options.

Moisten all surfaces just prior to placing concrete in the patch area. Be sure there is no free standing water in the repair area. Pour and vigorously tamp or vibrate concrete into all areas of the repair. Strike concrete level or slightly higher than adjacent roadway slabs. If concrete contains heavy amounts of additives, it will appear sticky and be difficult to trowel. In these instances you may use a pre-packaged finishing aide to assist in the troweling operation. Both Sika and Eucolid Concrete Products have such finishing aid products.

Finishing shall consist of smoothing the entire patch surface with a bull float. Then use a heavy broom or tine rake to provide a friction surface with the tines running perpendicular to traffic. After finishing is complete, spray the entire patch with approved curing compound or lay wet burlap over the patch and keep wet through the concrete curing period.

If early opening for traffic is anticipated, concrete cylinders can be taken to determine adequate strength of the patch before removing traffic control. Minimum concrete strength should be 3000 psi before allowing traffic on patched areas.

150.0 BRIDGES

Bridge maintenance and inspection are included in the following sections.

150.1 Definitions

Bridges: All structures having an opening measured along the center of the roadway of more than 6.1 m (20 feet) between abutments or spring lines of arches or extreme ends of openings for multiple boxes. It may also include multiple pipes where the distance between the openings is less than half the smallest pipe's opening.

Short Spans: All structures 6.1 m (20 feet) or less, as defined under "Bridges" above. Structures with a clear span of less than 3 m (10 feet), measured normal to center line of features intersected are not included in the inspection program.

Culverts: Metal pipe, timber, concrete culverts and other structures with less than 3 m (10 feet) of clear span measured normal to center line of feature intersected.

Overpass: A grade separation where the subject highway passes over the intersecting facility.

Underpass: A grade separation where the subject highway passes under the intersecting facility.

Grade Separation: A structure carrying traffic of one highway over another highway.

150.2 Responsibilities of Headquarters Maintenance

The Headquarters Maintenance Engineer is responsible to ensure the following activities with regards to bridge maintenance are performed:

a) Assist the Districts in identifying and justifying projects for contract repairs.

b) Assist the Districts when requested on all projects involving state forces repairs.

c) Coordinate with the Districts on all projects that involve specialty repairs to ensure the operations are planned and executed properly.

d) Provide supplementary material resources to the Districts for bridge repairs by state forces.

e) Develop and maintain the "Bridge and Drainage Maintenance Course" and assist in its teaching.

f) Provide technical advice on materials and repair procedures for projects involving state forces.

150.3 Responsibilities of the Districts

The District Engineer is responsible for all structures within their respective district.

The District Engineer will ensure the following activities with regards to bridge maintenance are performed:

a) Initiate all projects for contract repairs.

b) Request assistance and consultation from headquarters maintenance and bridge design on all projects involving technical or non-routine maintenance and repairs.

c) Assist Headquarters Maintenance on all projects that involve specialty repairs and the Headquarters Maintenance Quality Specialist (MQS) as needed (e.g., traffic control and flaggers).

d) Performing delamination studies, chloride tests, and half-cell studies on bridge decks, superstructures, and substructures.

e) Provide all materials for bridge repairs by state forces.

f) Ensure routine, visual inspections of all bridges are performed per Subsection 150.11.

g) Ensure restricted bridges are posted per Subsection 150.6.

150.4 Responsibilities of Headquarters Bridge Section

The Bridge Engineer is responsible to ensure the that following bridge activities are performed:

a) All necessary routine, underwater, and in-depth inspections required by federal law.

b) Assist the Districts in identifying, justifying and estimating projects for contract repairs.

c) Provide technical advice and perform designs on repair projects involving state forces and contract repairs.

d) Coordinate through Bridge Inspection with districts to ensure bridges are properly posted, if required.

e) Perform bridge capacity and load analysis.

f) Develop and maintain a bridge management system that will coordinate all necessary repairs to the Districts and Headquarters MQS and assist in prioritizing these repairs.

150.5 Performance of Bridge Maintenance Activities

Bridge maintenance activities are the responsibility of the district with assistance provided by the MQS as necessary. The following guidelines are flexible and will vary depending on workloads, crew size, crew expertise, and equipment available. The district crews will perform all cleaning activities, including a yearly water flush of all decks, drains, bearings, joints, pier caps, abutment seats, concrete rails and parapets each spring. District crews will also be responsible for all preventive maintenance activities such as painting, coating and sealant applications and for routine, minor deck patching and railing repairs. District crews will also perform maintenance of the stream channel to include: debris removal, stabilizing banks and correcting erosion problems. The Districts will also coordinate all sign and utility repairs and handle emergencies as necessary.

The District Bridge and Building crews should anticipate the need for technical and specialized repairs to include: jacking up the structures, crack repairs, epoxy injection, repairing or adjusting bearing systems, repair and sealing of expansion joints, repair or reinforcement of main structural members to include stringers, beams, piers, pier and pile cap, abutments and footings, underwater repairs, major deck repairs, and major applications of coatings and sealants.

The District should plan and budget for contracting all bridge maintenance activities too large for the district bridge and building crew to accomplish.

The Headquarters MQS is available to assist the district in planning, coordinating, and performing technical and specialized repairs described above. The MQS will also provide assistance for emergency repairs involving the above components and activities.

150.6 Posting of Bridges

Each bridge will be analyzed for its load capacity based on the structural conditions documented in the field inspection report. Capacity is reported in terms of three typical vehicles according to Section 6 of "Manual for Condition Evaluation of Bridges." The typical trucks are:

Type 3	3-axle truck with a GVW of 24,490 kg (27 tons).
Type 3S2	5-axle truck and semi-trailer with GVW of 40,820 kg (45 tons).
Type 3-3	6-axle truck and trailer with GVW of 38,100 kg (42 tons).

Posting is mandatory when the typical vehicle weight develops stresses in the bridge that are 75 percent or more of the yield stress of the material. The Bridge Inspection

Engineer prepares the "Bridge Safety Analysis," outlining the operating restrictions and maximum gross vehicle weights to be posted. Districts will do the posting.

150.7 Emergency Bridge Repair and Closure

See Section 322.1, Bridge Closure.

150.8 Overlays and Bituminous Chip Seals Coats on Bridges

The placement of plant mix overlays and bituminous chip seal coats on bridge decks is discouraged and will be allowed only under the following conditions:

a) Be verified by the Bridge Engineer as structurally acceptable early in the planning phase.

b) Employ protective measures for expansion joints to ensure the filler material is not damaged and open joints are not contaminated with plant mix or emulsion.

c) Have a waterproof membrane seal placed on the concrete surface underneath it.

d) Be placed no thicker than 50 mm (2") total of all composites.

150.9 Vertical and Overhead Clearance on Bridges

It is the intent of the ITD Maintenance Section to maintain horizonal and vertical clearances on all structures at distances not less than shown on the as constructed plans or as required by agreements with the railroads on underpasses.

Current design standards for vertical clearances on Idaho routes call for 4.9 meters (16 ft.) minimum. Any clearance less than 4.9 meters must be posted in accordance with Section 167.5 of the Traffic Manual.

It is critical that any changes in horizontal or vertical clearances be coordinated well in advance with the Special Permits Unit.

150.10 Local Bridge Inspection Program

The Local Bridge Inspection Program will be administered by the Bridge Inspection Engineer. The information derived from the local bridge inspection program is transferred to the appropriate local jurisdiction to establish a list of bridges eligible for rehabilitation or replacement using federal funding.

150.11 Routine Maintenance Inspection of Bridges

Routine inspection of bridges should be performed periodically by maintenance personnel during regular patrols. Inspections should be at least once every six months or after any potentially harmful natural event such as an accident, major

storm, flood, earthquake, etc. The section foreman or lead man should perform a visual inspection of each structure and note this in his log. Any problems or questions should be referred to the District Maintenance Engineer or Regional Engineer and then to the Bridge Inspection Engineer at the discretion of the District Engineer. During routine inspections, maintenance personnel should note any sags or deformities in the deck or rail, any erosion of fills, any scour of piers or footings, any problems with bearing systems and any damage resulting from accidents. Areas needing routine cleaning should also be noted and scheduled for action.

150.12 Bridge Damage Inspection and Reports

In the event that there is an accident, incident or suspected damage to any bridge the local maintenance foreman or lead man will complete the bridge damage report form shown in Figure 150.12 and promptly notify the District Maintenance Engineer or Regional Engineer and the Bridge Inspection Engineer. Copies of the damage report should be faxed to the above personnel as soon as possible.

The District Engineer will decide if the bridge is to remain open while the Bridge section is evaluating the damage.

When damage is discovered to bridges owned by others (railroad, city, etc.), that agency will be notified immediately.

Figure 150.12

BRIDGE DAMAGE REPORT

DATE _____ DISTRICT _____

LOCATION: ROUTE _____ MILEPOST _____

STRUCTURE ID NUMBER _____

FEATURE DESCRIPTION _____

_____

APPROXIMATE DATE AND TIME OF DAMAGE _____

GENERAL CAUSE AND DESCRIPTION OF DAMAGE _____

_____

_____

SKETCH OF DAMAGE [SHOW NORTH ARROW, DIRECTIONS OF TRAFFIC, WATER FLOW, ETC., AND LABEL ROADS (INCLUDE PHOTOS WHEN POSSIBLE)]:

DATE IDAHO STATE POLICE NOTIFIED (IF ACCIDENT) _____

DATE DISTRICT MAINTENANCE ENGINEER NOTIFIED _____

DATE BRIDGE INSPECTION ENGINEER NOTIFIED _____

REPORT PREPARED BY _____ DATE _____

DISTRIBUTION: DISTRICT ENGINEER, DISTRICT MAINTENANCE, HQ BRIDGE, HQ MAINTENANCE

151.0 BRIDGE SUPERSTRUCTURE REPAIR

The District Maintenance Engineer or Regional Engineer will coordinate all major repairs reinforcements and replacements with the Bridge Engineer. This will include all actions on stringers, girders, beams, main truss members, etc., that are other than cosmetic in nature. When plans, detailed drawings or special procedures are needed, the Bridge Engineer will assign a staff member to prepare these. A structural engineer will review all plans, and procedures.

Welding on all main or critical steel members will be performed by a certified welder.

152.0 BRIDGE DECK REPAIR

Major repairs, rehabilitations, replacements and concrete overlays will normally be performed by contract. If performed by state forces, the project will be treated as a superstructure repair and accomplished as outlined in Subsection 151.0 above.

Temporary patches using plant mix pavement may be used by district forces to provide a smooth and safe ride for the traveling public until more permanent repairs can be made. The area to be patched should be clean and dry and all loose concrete removed by hand or power tools prior to placing the plant mix.

Once placed, the plant mix should be compacted to match the existing deck grade.

General concrete patching will be accomplished as follows:

1. Sound or chain drag the area around the deteriorated area to determine the extent of the damage and mark all unsound areas to be removed.

2. Saw cut the deteriorated area to an approximate rectangular form. Saw cut to a minimum depth of 8 mm (1/4 inch). Avoid cutting the rebar or any acute angles on the patch edge. No feathered edges should be allowed anywhere on the patch.

3. Remove the concrete within the cut area using hand or mechanical means that do not exceed 135 Newtons (30 lb. force) in rating. Removal should be to a depth below the rebar mat of twice the size of the largest stone in the patching material.

4. Clean the area to be patched by sand or water blasting ensuring all rust is removed from the rebar and all scale is removed from the edges. Air blast the area to remove any sand or water.

5. Mix, place and cure the patching material according to manufactures recommendations. Ensure the patch surface matches the existing surface grade.

Only appropriate patching materials designed for the purpose intended will be used when possible. All approved patching materials will not have exceeded their storage life. Materials that have low shrinkage, high modulus, high bond, low permeability, and thermal coefficients of expansion similar to concrete will be used when possible. If elastomeric concrete is used, it should not be placed around reinforcing steel unless absolutely necessary. For any deck patching materials recommendations, contact the Maintenance Quality Specialist.

153.0 BRIDGE JOINT REPAIR AND SEALING

Bridge joint repairs and sealing will include all activities necessary to provide functional expansion joints that prevent water leakage onto the bearings and substructure and include: rebuilding or patching the joint edges, installation of modular or strip seal systems, installation of joint filler/sealer material, installation of drainage troughs, and adjustments or securement of the joint components.

Rebuilding or replacement of joint edges will be performed using modified, durable, impact resistant concrete and/or properly secured steel armor for the joint edge material. Decks with plant mix overlays will utilize an elastomeric concrete header a minimum of 400 mm (8 inches) in width and the full depth of the asphalt overlay as a paving dam to retain the plant mix on the deck. For product recommendations of joint materials or joint edge repair materials, contact the Maintenance Quality Specialist.

154.0 BRIDGE SUBSTRUCTURE REPAIRS

Substructure repairs will consist of all repairs on pier caps, piers, bents, piles, abutments, wing walls, and footings. Work will be performed under the same guidelines outlined for superstructure repairs. Concrete patching will be performed as outlined in Subsection 152.0 and may utilize a patching material more suitable for vertical applications. For product recommendations, contact the Maintenance Quality Specialist.

Cracks in concrete are a major problem in many substructure components. Cracks equal to or larger than l mm in width should be filled and sealed with a high grade, 100% solids epoxy following the manufactures recommendations. Cracks smaller than 1 mm should be treated as described in Subsection 156.0.

155.0 BRIDGE BEARING SYSTEM REPAIR OR ADJUSTMENT

This activity will consist of all repair and adjustment work involving the bridge bearing units or systems to include: rockers, rollers, pots, elastomeric pads, etc.

Work will be performed under the same guidelines as outlined for superstructure repairs.

156.0 BRIDGE PAINTING/COATING/SEALING

This activity will consist of all protective and preventative maintenance activities designed to prevent deterioration of structure components.

All components made of non-weathering steel will be painted with an approved zinc or alkyl base paint at a frequency necessary to protect the steel from rust and corrosion. Bridges painted prior to 1975 probably used lead, chromiumor, cadmium based paint which if removed must be removed according to strict EPA and OSHA guidelines and disposed of as a hazardous waste. As an alternative to removal, some toxic based paint may be in a condition that will permit an overcoating of paint which will effectively contain the toxic material and protect the steel. Prior to any major painting application, the existing paint must be sampled and the Headquarters Material Section consulted for an appropriate paint system.

Spot painting can be performed by maintenance forces using the following guidelines:

1. If the paint has not been proven to be lead/chromium/cadmium free, treat it as if it were hazardous and brief personnel accordingly (refer to OSHA pamphlet 3126).

2. Personnel removing the paint should wear coveralls, gloves, goggles, and a certified, properly fitting respirator for protection.

3. Ensure a containment system is arranged to catch and retain all the paint removed.

4. Apply an approved chemical paint remover on the desired area and allow it to stand.

5. Remove the paint with hand tools or scrapers that do no not cause the paint particles to become airborne.

6. Dispose of hazardous paint at the nearest district headquarters yard at the hazardous waste site in the area marked for toxic paint. Inform district personnel.

7. Prepare and clean the now paint-free surface and repaint the area with an approved paint.

8. Ensure that personnel do not eat, drink or smoke until they are finished and have washed and properly disposed of all contaminated tools and clothing.

Cracks in any bridge component should be evaluated and corrective action taken. A crack in any steel component must be promptly reported to the Bridge Engineer and

corrected per his/her recommendation. Cracks in wood or concrete should be evaluated first and then cleaned and sealed with an appropriate crack sealant. Larger cracks in concrete should be sealed with polymer or epoxy based sealants. Small shrinkage cracks and all concrete surfaces where the concrete is not a specialized or high density concrete such as latex modified or silica fume concrete should be treated with a silane based sealant.

157.0 BRIDGE CURB AND RAILING REPAIR

This activity involves repair or replacement of bridge curbs, medians, parapets, and railing damaged by accidents, deterioration or vandalism to ensure a safe condition for motorists and pedestrians.

Concrete will be repaired as outlined in Subsection 152.0.

158.0 BRIDGE ACCESSORY REPAIR

Activities performed under this category will include all repairs and modifications to approaches, drainage systems, catwalks, sidewalks, cathodic protection devices, ice detection and anti-icing devices, retaining walls, slope paving, fill material, fill stabilization systems and all other items except stream channel features which will be addressed under Maintenance Activity Code M251 - Channel Repair.

The bridge approach must provide a smooth transition to the deck to avoid impact damage. Bituminous ramps can be placed to adjust the grade higher or milling can be used to lower it.

Drainage systems must be directed away from all structural components and modified to prevent erosion. Erosion causes must be identified and corrected. All erosion channels must be filled and compacted with a suitable fill material.

This activity will also be used to address repairs or modifications to utility features such as water, sewer, telephone, cable television, or electrical lines that may be associated with the bridge. Except for emergency, temporary, repairs, work on these features will be performed by the appropriate utility under the supervision of a qualified state inspector. Any modifications other than to restore the utility to its original condition must be approved by the Bridge Engineer in advance.

Specialized features such as cathodic protection devices, ice detection and anti-icing devices, and specialized geotextile systems should be repaired or modified by a qualified technician or in accordance with manufactures recommendations.

Concrete will be repaired as outlined in Subsection 152.0. Major changes to or deletions of any of these features should be reviewed and approved by the Bridge Engineer prior to taking action.

159.0 BRIDGE CLEANING

This work will consist of cleaning all bridge components that are susceptible to dirt, debris, bird dropping and deicing salts.

Drainage systems and components subject to dirt or bird droppings accumulation will be cleaned regularly as needed by hand tools, air blasting or preferably water flushing. Dust or any material that could be inhaled should be avoided by the use of a proper respirator.

Other components such as bare concrete decks, pier caps, abutment seats, bearing systems, non-sealed or open expansion joints, joint drainage troughs, head walls, wing walls, select beam flanges, truss joints etc. should receive a thorough water flush every spring (after applications of deicing salts have ceased) as a bare minimum. Whenever possible, a silicone sealant should be applied to all porous surfaces after cleaning.

Personnel should become familiar with various types of bearing devices. Mechanical bearing devices should be lubricated after cleaning to prevent rusting and assist in their movement.

Clearing of weeds, float debris, brush and overhanging limbs from the vicinity of the bridge will be performed under Maintenance Activity M251 - Channel Repair.

160.0 BRIDGE INSPECTION

160.1 Operational and Instructional Manuals

The operational and instructional manuals developed for reference are:

l) Current "Standard Specifications for Highway Bridges," adopted by AASHTO.

2) Current "Manual for Condition Evaluation of Bridges", prepared by AASHTO.

3) The "Bridge Maintenance Inspection Coding Procedures Manual," prepared by the ITD.

4) Current "Bridge Inspector's Training Manual," prepared by the U.S. Department of Transportation/Federal Highway Administration.

160.2 Responsibilities for Bridge Inspection

The Bridge Inspection Engineer is responsible to ensure that a bridge inspection program is in place for all state, local and off-system bridges that meets all federal and state requirements. The Bridge Inspection Engineer will ensure that each bridge receives inspections at a frequency in accordance with its condition an traffic characteristics but not less than the frequency required by Title 23 Code of Federal Regulations.

The Bridge Inspection Engineer is responsible to ensure that the bridge inspection data base on state, local and off-system bridges is maintained properly, that all structures are inventoried, and that yearly updated reports (or magnetic tapes) on bridge status and critical bridge maps are prepared for the Federal Highway Administration and ITD sections. The Bridge Inspection Engineer will also ensure that all inspectors receive the necessary training to perform the inspections necessary.

160.3 Bridge Inspection Reports

The certified Bridge Inspector makes field inspections and prepares structural condition reports on form DH-325A "Bridge Field Inspection Report." The Inspector submits the report with photographs of the approach view and the elevation view of the bridge to the Bridge Inspection Engineer for review. An approved copy will be sent to each district which shall maintain a file of inspections for future reference.

Maintenance needs will be identified and quantified by the Inspectors and assigned to the districts or the headquarters maintenance crews based upon the guidelines outlined in Subsection 150.5.

161.0 STANDARD BRIDGE INSPECTION

Bridge Inspectors should confer with the Maintenance Foremen in each area on all bridges in that area of any suspected or reoccurring problems they are having.

Bridges will be inspected by a licensed engineer or certified bridge inspector at the following frequency unless conditions warrant more often:

1) All weight limit posted bridges and all bridges with questionable conditions will be inspected yearly.

2) Normally all bridges will be inspected at regular intervals not to exceed two years.

3) Certain types or groups of bridges where past inspection reports and favorable conditions and analysis exist may justify less inspection frequency. Upon FHWA approval inspection intervals of up to 4 years may be implemented.

162.0 UNDERWATER BRIDGE INSPECTION

Bridges with underwater members that cannot be visually evaluated during periods of low flow will have underwater inspections performed on them not less than once every 5 years. Those determined to be scour susceptible will be inspected at a frequency as determined necessary by the Bridge Inspection Engineer.

Underwater inspections will be performed by certified divers that have been trained to identify problems and that are under the supervision of a certified bridge inspector.

163.0 IN-DEPTH BRIDGE INSPECTIONS

In-depth bridge inspections will be performed on all critical bridges and certain types of bridges at a frequency determined by the Bridge Inspection Engineer.

These inspections may be performed in house or by consultants and will thoroughly inspect and test all bridge components.

Use of ITD bridge inspection cranes on roadways will utilize a crash truck for protection in addition to normal traffic controls.

164.0 BRIDGE ANALYSIS OF LOAD CAPACITY

The bridge analysis of load capacity will be performed on each bridge on the state, local and off-system. Analysis of the bridges will be performed in house using the "Bridge Analysis Rating System" (BARS) or other viable methods.

165.0 BRIDGE MAINTENANCE INSPECTION PROGRAM ADMINISTRATION

This activity will encompass the general administration for inspection and inventory of all bridges on the state, local and off-system bridges in accordance with Title 23 of the Code of Federal Regulations.